ARAC WG Report

Report from the Loads and Dynamics Harmonization Working Group

Rule Section: FAR/JAR 25.865

1 - What is underlying safety issue to be addressed by the FAR/JAR? [Explain the underlying safety rationale for the requirement. Why should the requirement exist? What prompted this rulemaking activity (e.g., new technology, service history, etc.)?]

FAR 25.865 is intended to ensure adequate structural load carrying capabilities at elevated temperatures of essential flight controls, engine mounts, and other flight structure in, or adjacent to, designated fire zones when subjected to fire conditions in order for them to continue to perform their intended functions.

Historically, FAR 25.865 was added to Part 25 by amendment 23 in 1970, although the same requirement had existed for rotorcraft for many years. The need for this rule for transport category airplanes was highlighted when airplane control problems were experienced on a jet transport airplane after aluminum control rods located outside of the fire zone became distorted due to heat from an engine fire. Aviation safety release No. 453, dated November 9, 1961, states that a helicopter component necessary for controlled landing in the event of fire must sustain the loads and perform the function for which it was designed when subjected to a test flame of 2000° F for 15 minutes. This document formed the basis of the current advisory material for transport and utility helicopters and has been applied to various transport category airplane certifications before the advent of Advisory Circular (AC) 20-135. Although the AC 20-135, "Powerplant Installation and Propulsion System Component Fire Protection Test Methods, Standards, and Criteria", contains the protection criteria for powerplant installations, it does not address any means of compliance with FAR 25.865, particularly for the load carrying engine mount systems.

2 - What are the current FAR and JAR standards relative to this subject?

The current FAR and JAR standards are identical.

<u>Current FAR/JAR text</u>: Essential flight controls, engine mounts, and other flight structures located in designated fire zones or in adjacent areas which would be subjected to the effects of fire in the fire zone must be constructed of fireproof material or shielded so that they are capable of withstanding the effects of fire.

2a – If no FAR or JAR standard exists, what means have been used to ensure this safety issue is addressed?

Not applicable.

3 - What are the differences in the FAA and JAA standards or policy and what do these differences result in?

The definition of "fireproof" used in both standards differs in their FAR 1/JAR 1 definitions.

FAR 1 fireproof definition:

(1) With respect to materials and parts used to confine fire in a designated fire zone, means the capacity to withstand at least as well as steel in dimensions appropriate for the purpose for which they are used, the heat produced when there is a severe fire of extended duration in that zone; and

(2) With respect to other materials and parts, means the capacity to withstand the heat associated with a fire at least as well as steel in dimensions appropriate for the purpose for which they are used.

JAR 1 fireproof definition:

With respect to materials, components and equipment, means the capacity to withstand the application of heat by flame, for a period of 15 minutes without any failure that would create a hazard to the aircraft. The flame will have the following characteristics:

Temperature	1100°C ± 80°C
Heat Flux Density	116 KW/m^2 ± 10 KM/m^2

Note: For materials this is considered to be equivalent to the capability of withstanding a fire at least as well as steel or titanium in dimensions appropriate for the purpose for which they are used.

The JAR 1 definition contains the fire threat to be addressed, i.e. temperature, time, and heat flux. The FAR definition is a more objective based rule, with the same fire threat contained in the advisory material AC 20-135, and reflects general material types that are deemed acceptable. In this aspect, the JAR definition also includes titanium as well as steel as a fireproof material within the rule.

The FAR 1/JAR 1 definitions for fireproof are used throughout the FARs and JARs. Although the JAR 1 definition incorporates the flame temperature, duration, and heat flux, the definition also includes a note that accepts both steel and titanium as fireproof.

Recently, the FAA has been presented several certification programs where applicants have complied with the JAR fireproof definition, as contained in JAR 25.865, using titanium engine mounts. The FAA has considered that the engine mount structures made of titanium may not be equivalent to steel in terms of load carrying capability at elevated temperatures, and therefore, under current policy does not accept titanium mount structures as meeting the requirements of FAR 25.865 without substantiation by a fire test and/or analysis.

As a result, in 1987-88 timeframe, the FAA developed an issue paper for FAR 25.865 to address the need to show that titanium and other non-steel engine mounts will perform their intended function under fire conditions and appropriate loads. The assessment of the engine mount configuration does take into account such features as shielding and redundant load paths.

The differences in FAA and JAA policy on 25.865 compliance described above have not resulted in design changes to current generation titanium engine mounts submitted to the authorities for certification.

4 - What, if any, are the differences in the current means of compliance? [Provide a brief explanation of any differences in the current compliance criteria or methodology (e.g., issue papers), including any differences in either criteria, methodology, or application that result in a difference in stringency between the standards.]

As stated above, the FAA considers that the engine mount structures made of titanium may not be equivalent to steel in terms of load carrying capability at elevated temperatures, and has therefore not accepted titanium as meeting the requirements of FAR 25.865 without substantiation by test and/or analysis. The FAA developed an issue paper to address the need to demonstrate that the particular engine mount installations will perform their intended function under fire conditions and appropriate flight loads.

5 – What is the proposed action?

Advisory Material

The proposed action is to publish new harmonized AC/ACJ advisory material that will provide a methodology for establishing a "fireproof" material structural standard/rating; see attachment, and also item 13 below. This rating threshold would allow acceptance of load carrying materials capable of withstanding the effects of fire at least as well as a reference steel classification in dimensions appropriate for the purpose for which they are to be used without fire tests and/or analysis. Additionally, assessments at the component and installation level can be made when the structural materials cannot be shown to be "fireproof", i.e. meet the fireproof structural standard, considering such items as shielding and redundancy (fail-safe features).

In addition, the advisory material will define the extent of applicability of 25.865 to engine-side and airframe-side mount structure.

There would not be any change to the existing harmonized requirement.

Test Program

Certain testing is necessary to validate the proposed fireproof rating methodology, as well as to determine certain fireproof rating values, as outlined in the AC/ACJ. The FAA Technical Center, Fire Safety Section - AAR-422, has been contacted and is prepared to conduct this testing. The FAA is requested to proceed with this test program as outlined in the attachment. It is anticipated that the FAA representative to the LDHWG will work with the Technical Center throughout the test program and provide information to, and seek assistance from the working group as necessary. Upon completion of the test program, the LDHWG will regroup to finalize details in the advisory material associated with the material fireproof ratings.

6 - What should the harmonized standard be?

The standard is currently harmonized. There are no changes being proposed to the current standard.

7 - How does this proposed standard address the underlying safety issue (identified under #1)?

Since there would be no change to the existing standard, this proposal would continue to address the underlying safety issue in the same manner as it does currently.

8 - Relative to the current FAR, does the proposed standard increase, decrease, or maintain the same level of safety? Explain.

The proposed new policy/advisory material will maintain the level of safety intended by the existing standard and for installations previously approved.

9 - Relative to current industry practice, does the proposed standard increase, decrease, or maintain the same level of safety? Explain.

Maintain. Current industry practice, while not completely uniform, is generally consistent with the proposed means of compliance in the advisory material.

10 - What other options have been considered and why were they not selected?

One option that was considered was defining a "foreseeable" or realistic fire condition which could replace the standard flame definition for use in component or part analyses. This was proposed as a 2000° F temperature flame as the fire "source" on the various components individually, with representative, lower zonal temperatures (800° -1000°F) on redundant components of the engine mount installation.

Under this approach, the basic "intent" of the rule - to provide a sufficient strength capability in a foreseeable fire - would be met. A foreseeable fire is not necessarily 2000°F nor does it last for precisely 15 minutes, and there may be some installations for which this performance criterion might not be met, but the installation is sufficiently protected against the foreseeable fire.

The task group did not feel that a "foreseeable" fire could be defined at this time due to the lack of actual nacelle fire data concerning heat flux, temperature, and size, and supported the current standard flame definition as the appropriate requirement for providing consistent results. Thus, the use of the standard AC 20-135 or ISO 2685 flame has been found to be an acceptable representation of a foreseeable fire condition for the purposes of compliance with paragraph 25.865.

11 - Who would be affected by the proposed change?

Manufacturers of transport category airplanes and engine, and APU manufacturers could be affected by the proposed advisory material. With the establishment of a new fireproof structural rating for materials in the proposed advisory material, and after initial specimen tests and/or analyses of more commonly utilized materials are conducted, no testing or analysis would be required for the acceptable materials. New or changed materials would require test or analysis to define their rating levels.

12 - To ensure harmonization, what current advisory material (e.g., ACJ, AMJ, AC, policy letters) needs to be included in the rule text or preamble? [Does any existing advisory material include substantive requirements that should be contained in the regulation? This may occur because the regulation itself is vague, or if the advisory material is interpreted as providing the only acceptable means of compliance.]

AC 20-135 is adequate in providing guidance for the standard flame properties definition for fire test methods. The JAR standard currently reflects the same properties definition.

FAA Policy Memo 96-ANM-112-14, "Engine-Airplane Regulatory Interface", dated November 13, 1996, describes the consideration for engine-side hardware during mount assessment for damage tolerance and failsafe design. This philosophy is used in application to mount fire requirement under 25.865 and is clarified in the attached advisory material.

Generic Issue Paper, "Fire Protection of Structure and Systems in Fire Zones" describes the current FAA position on non-steel engine mount structures.

13 - Is existing FAA advisory material adequate? If not, what advisory material should be adopted?

There is no existing advisory material for the rule. New advisory material for § 25.865 is proposed; see attachment.

In showing compliance to the proposed advisory material, the "materials structural rating" concept is a simplified approach for validating structural materials against those that have historically been shown as having acceptable resistance to the effects of fire. The materials structural rating will ensure that an acceptable level of safety will be maintained irrespective of the detail configuration of the components and parts when they are sized to comply with the other relevant certification requirements.

This alternative approach, where the installation is accepted without further evaluation, will be based on an appropriately conservative level consistent with industry experience. It is possible that even some steel classifications might fall below the acceptable rating level. This does not mean that materials falling below the acceptable rating level are "prohibited", but they would not receive the "no further evaluation" approach, but must be evaluated with respect to the installation.

14 - How does the proposed standard compare to the current ICAO standard?

The ICAO standards are higher level standards that do not go into the detail of this proposed change. This proposal does not conflict with the current ICAO standards.

15 - Does the proposed standard affect other HWG's?

The PPIHWG has forwarded a new FAR1/JAR1 fireproof definition that no longer includes a provision for equivalence to steel or titanium. The guidance material forwarded herewith is based on the provision for equivalence to steel in the existing FAR1/JAR1 definition. The LDHWG believes it is appropriate to proceed without waiting for a new fireproof definition, which may be years in the making, and which may change before finally published. Furthermore, in the event the new definition is published, the LDHWG believes the approach outlined in the proposed AC/ACJ will remain valid.

The EHWG is also impacted due to harmonization activity related to FAR 33.17 and the equivalent JAR. The latter contains a fireproof engine mount requirement, which is not contained in FAR 33.17. After the LDHWG makes its recommendation with regard to FAR/JAR 25.865, the EHWG intends to revisit the fireproof engine mount criteria and determine how it should be covered by engine regulations.

16 - What is the cost impact of complying with the proposed standard?

The overall cost to manufacturers should be equal to or lower because adoption of the proposed, harmonized advisory material would allow applicants to demonstrate compliance with acceptable materials relative to the fireproof structural rating without additional tests or analyses. For other materials ("non-fireproof" materials), assessments can be done at the component and installation level as is currently practiced. However, in some specific instances certification costs may increase due to more uniform application of the standard for these instances.

17 - If advisory or interpretive material is to be submitted, document the advisory or interpretive guidelines. If disagreement exists, document the disagreement.

The proposed advisory material is attached. There are no disagreements on this submittal.

18 - Does the HWG wish to answer any supplementary questions specific to this project?

Yes.

Question: What is the service experience for engine mounts relative to the safety issue expressed in question 1?

Answer: The HWG examined all available data regarding fires and their effect on engine mounts. The task group examined manufacturer data provided by Boeing, Airbus, Pratt & Whitney, General Electric, Rolls Royce, Snecma, Cessna, and Honeywell. While the data confirmed that engine fires occurred generally at a rate of 10-6 per flight hour over approximately a billion installation hours, there were no recorded instances of a mount ever being compromised on any transport aircraft installation due to fire.

The HWG also reviewed the experience accumulated on various mount materials for Boeing, Airbus and Cessna installations of Pratt & Whitney, General Electric, Rolls Royce – Allison, Honeywell, CFM, and IAE engines. The numbers presented represent a rough, conservatively low estimate of the experience using these materials in components of mount applications and does not represent the entirety of the industry experience. Information was not immediately available for several installations with significant experience, notably DC-9, MD-80, L-1011 and Rolls Royce installations on Boeing airplanes. The most widely used materials experience is summarized in the table below:

Material	Front mount hours (Million)	Aft mount hours (Million)
15-5 PH Steel	314	90
4000 Series Steel	343	unknown
410 Steel	525	0
Inco 718	124	392
Greek Ascolloy	0	746
6-4 Titanium	392	11
6-2-4-2 Titanium	0	12

19 - Does the HWG want to review the draft NPRM at "Phase 4" prior to publication in the Federal Register?

Yes

20 - In light of the information provided in this report, does the HWG consider that the "Fast Track" process is appropriate for this rulemaking project, or is the project too complex or controversial for the Fast Track Process? Explain.

Yes, the "Fast Track" process is appropriate for this project.

Proposed FAA Technical Center Test Program

Objective

Certain testing is necessary to validate the proposed testing methodology, as well as to determine certain fireproof rating values, as outlined in the AC/ACJ. The FAA Technical Center, Fire Safety Section - AAR-422, is requested to conduct this testing, in cooperation with the FAA representative to the LDHWG. It is anticipated that the FAA representative to the LDHWG will work with the Technical Center throughout the test program and provide information to, and seek assistance from the working group as necessary.

Basic Assumptions

1. The proposal is to compare the loss of ultimate tensile strength (UTS) of a standardised specimen (comparison bar) to a reference steel bar of 4000 series steel material when subject to 5 and 15 minutes exposure to a standard flame. Those materials exhibiting the same or lesser degradation than the reference steel are considered acceptable as "fireproof" without further validation. The materials used for comparison to the reference steel should be taken from the list of materials provided in the AC/ACJ.

2. The reference steel bar will be tested as defined below. Conduct the same test with the comparison bar except that the diameter should be adjusted so that the ultimate static load carrying ability in tension at room temperature between the comparison bar and the reference bar are the same.

3. It is proposed that the testing be restricted to a single external size and shape and hence present a uniform set of heat input characteristics with respect to the flame. In order to allow for some limited effects of thermal conductivity and density effects it is proposed that the reference steel sample be a tube 1.5" OD and 1.0" ID*. On this basis, lower strength materials have a potential increase in cross sectional area to achieve the same operating temperature UTS as the reference steel bar, without increasing its diameter.

   *The dimensions provided may need to be adjusted in order to be able to successfully complete the testing. The FAA should determine the best dimensions to use for the reference bar, possibly based on some testing, and also based on the availability of materials of the appropriate dimensions.

4. The test bar length is proposed as 30".

5. Using material strength vs. temperature data (average properties) for the reference bar material and the comparison bar material, determine the minimum ratio of the comparison material strength to the reference steel strength during the 15 minute time period. This will be considered the "structural fireproof rating". Structural materials demonstrating a fireproof rating greater than <u>1.0</u> may be considered compliant with the intent of § 25.865 without further substantiation.

Proposed FAA Technical Center Test Program, cont.

Proposed test procedure

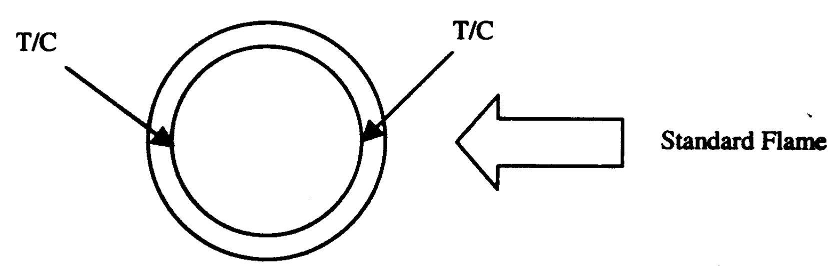
1. A 30" test specimen for each material would be prepared having a UTS equal to that of the reference steel material sample of 1.5" OD and 1.0" ID (or appropriate dimensions). The specimen would be instrumented with 2 thermocouples installed at the center to read the wall temperature of the bar at two points on the diameter. The lead out should be ideally within the tube, or failing that along the rear of the section to minimize aerodynamic impact of the lead outs on the wire.

2. The bar should be fire tested to the requirements of AC 20-135 or ISO 2685 with the burner positioned such that the calibrated section of the flame impacts centrally on the test specimen. The bar should be held in position is such a way that the impact of the mounting on the bar installation is minimal (the ideal would be a bar in free space). The thermocouple positions should be such that they are front and back (see figure 1).

3. Time temperature data during the fire test should be recorded.

4. For the assessment, the average temperature of the front and rear thermocouples should be used to determine from test sample or available data, the strength of the material at both the 5 and 15 minute points. Note: for novel materials these temperature/UTS levels should not result in significant creep within this test period.

FIGURE 1



DRAFT ADVISORY CIRCULAR No. 25.865-1
Fire protection of flight controls, engine mounts, and other flight structure

1. PURPOSE. This advisory circular (AC) sets forth an acceptable means, but not the only means, of demonstrating compliance with the provisions of part 25 of the Federal Aviation Regulations (FAR) related to the protection of flight controls, engine mounts and other flight structure from fires in designated fire zones on transport category airplanes.

   This advisory material applies to zonal fires and to low pressure fires and does not apply to "torching" fires resulting from engine casing burn through.

2. RELATED FAR SECTIONS AND ADVISORY MATERIAL.

   FAR 1, FAR 33.17, AC 20-135

3. BACKGROUND.

a. Section 25.865 "Fire protection of flight controls, engine mounts and other flight structure" was added to Part 25 by amendment 25-23 in 1970, although the same requirement had existed for rotorcraft since the early 1960's. The need for this rule for transport category airplanes was highlighted when control problems were experienced on a jet transport airplane after aluminum control rods located outside of the fire zone became distorted due to heat from an engine fire.

b. The rule was set forth by amendment 25-23 with essentially the same text that was used for transport (Category A) rotorcraft. The specific flight controls that were of concern for rotorcraft were those that were essential for making a controlled landing. For transport airplanes it was recognized that making a landing was not as simple and immediate as it could be for a rotorcraft so the rule was written to apply to "essential" flight controls without further qualification. Since engine mounts and other flight structures could also be affected, the rule was made to apply to those components as well.

c. FAA Flight Standards Service Release No. 453, dated November 9, 1961 (a forerunner of the current Advisory Circular system) stated that a component (structure, control, mechanism or other essential part) must resist flame penetration and remain capable of carrying the loads and satisfactorily performing the function for which they are designed when subjected to a standard test flame of 2000 degrees F for 15 minutes. Service Release No. 453 formed the basis of the current advisory material for transport and utility helicopters (AC 29-2A and AC 27-1) and has also been accepted for transport category airplane certification after the rule was adopted for transports.

d. Advisory circular AC 20-135 "Powerplant installation and propulsion system component fire protection test methods, standards, and criteria" contains acceptable information for compliance with the several fire protection requirements and includes the methods and criteria for conducting fire tests on components to establish that they are fireproof. When developing AC 20-135, it was recognized that to establish the fire integrity of structural elements and flight controls, the expected external loads during the fire event would need to be defined and considerations of fail-safety and redundancy would need to be addressed. Since these considerations would take more time to develop, the AC was published excluding applicability to § 25.865. The FAA has continued to rely on the criteria of Service Release No. 453 as the basic means of compliance, although the methods of fire testing and flame definition were slightly changed to be consistent with the fire definitions of AC 20-135.

e. The term "fireproof" is defined in AC 20-135 (for components other than firewalls) as the capability of a material or component to withstand as well as steel, a 2000 °F flame (± 150 °F) for 15 minutes minimum while still fulfilling its design purpose. FAR part 1 defines "fireproof" (for components other than firewalls) as the capacity to withstand the heat associated with fire at least as well as steel in dimensions appropriate for the purpose for which they are used. Other definitions have been proposed and used which do not refer to any specific material but require the component to withstand the 2000° F flame (± 150° F) for 15 minutes fire condition. Irrespective of what definition is used for the term "fireproof" for a structural member, the capability to withstand the fire condition is integrally tied to the loads expected to be applied to the structural member during the time of exposure to the fire. Experience has shown that essential flight structures, when constructed of steel, are capable of withstanding the loads likely to be applied during the exposure to the fire condition (2000° F flame (± 150° F) for 15 minutes). The use of materials that are equivalent to steel for structural members has been accepted.

f. For materials not shown to be equivalent to steel it has been necessary to consider the installation as a whole. This has required the consideration of shielding, redundancy and the available heat transfer mechanisms in combination with a set of design flight loads. Advisory Circular 25.571-1C, "Damage Tolerance and Fatigue Evaluation of Structure", provides design loads associated with discrete source damage conditions which would exist until landing. The design loads as described and contained in Section 7 are greater than the flight loads expected during the shorter duration of an in-flight fire, but nevertheless have been considered appropriate for conducting the evaluation of the complete structural installations exposed to the prescribed fire condition (2000° F flame (± 150° F) for 15 minutes).

4. <u>DEFINITIONS:</u>

a. <u>Foreseeable fire condition</u>: A realistic fire condition that is assumed for the purposes of qualitatively determining if a component or part could be affected by a fire in the fire zone.

b. <u>Designated fire zone</u>: A fire zone as defined in § 25.1181.

c. <u>Engine Mount</u>: For purposes of compliance to 25.865, the engine mount is considered to consist of the airframe engine mounting structure and engine-side attachment points and adjacent essential structure.

d. <u>Essential:</u> Necessary for continued safe flight and landing.

e. <u>Fire test condition</u>: The conditions associated with the standard fire test described in Advisory Circular AC 20-135 or ISO 2685.

f. Structural Fireproof rating: A fireproof rating relative to a selected standard steel which takes into account the specific heat capacity, conductivity, and strength variation with temperature.

5. DISCUSSION: This section provides several alternatives for addressing components that could be affected by fire in a fire zone. Note that firewalls used to contain the fire zone are considered to remain intact. Within a fire zone, the "effects of fire" relate to the direct flame impingement on the component or shielding if applicable. In areas adjacent to the fire zone the heat generated by the fire in the fire zone is the primary effect for consideration.

- They can be constructed of materials considered to be "fireproof".
- The design (arrangement and redundancy) can be such that the intended function can still be performed under the heat and other conditions likely to occur when there is a fire in the fire zone.
- The component can be shielded so that it is capable of withstanding the effects of fire.

For each of the assessments in the advisory circular, including the application of fire test conditions, validated analyses may be used to represent the transient temperature conditions and strength.

6. FIREPROOF STRUCTURAL MATERIALS.

a. Structural components. Engine mounts and other essential flight structures constructed of steel are considered capable of withstanding the expected flight loads during exposure to the fire condition (2000 °F flame (± 150 °F) for 15 minutes). For other materials intended to carry loads and resist failure in the fire condition, equivalency to steel may be accomplished by the following analytical or test demonstration designed to take into account the specific heat capacity, conductivity, and strength variation with temperature:

1) Unless other dimensions are agreed upon, consider a specimen of round bar of 4000 series steel (exact material TBD), 1.5 inches outside diameter (OD), 1.0 inches inner diameter (ID), and 30 inches long (i.e. 5 times the burner flame diameter). This is considered the reference bar.

2) The bar should be held in position in such a way that the impact of the mounting on the bar installation is minimal (the ideal would be a bar in free space).

3) Using a standard burner defined in AC 20-135 or ISO 2685, apply the heat to the center of the bar and determine the highest average cross section temperature vs. time during a 15 minute exposure.

4) Conduct the same test with the comparison bar except that the diameters (TBD) of the comparison bar should be adjusted so that the comparison bar and the reference bar have the same ultimate tensile strength.

5) Using material strength vs. temperature data (average properties) for the reference bar material and the comparison bar material, determine the minimum ratio of the comparison material strength to the reference steel strength during the 15 minute time period. This is the structural fireproof rating. Structural materials demonstrating a fireproof rating greater than 1.0 may be considered compliant with the intent of § 25.865 without further substantiation.

The following are the fireproof ratings for materials that have been found acceptable by the Administrator for demonstrating compliance with § 25.865:

(These materials will have to be further specified.)

Material	Fireproof rating
4000 series steel (reference)	TBD
Nickel Alloy 718	TBD
410 Steel	TBD
PH13-8Mo Steel	TBD
15-5 PH Steel	TBD
Titanium 6Al-4V	TBD
Titanium 6Al-2Sn-4Zr-2Mo	TBD
IMI 550	TBD
Greek Ascolloy	TBD

7. NON-FIREPROOF MATERIALS USED IN STRUCTURAL COMPONENTS AND INSTALLATIONS.

When the structural materials cannot be shown to be fireproof by paragraph 6, the following assessments at the component and installation level should be made.

Engine mounts and other essential flight structures should be able to sustain expected flight loads with a positive margin of safety for any foreseeable fire in a fire zone. In the absence of a rational definition of a foreseeable fire event and expected flight loads, each structural element should be individually subjected (as per paragraph 9b.) to the fire test conditions described in AC 20-135 (2000° F for 15 minutes) while sustaining the following loads:

- limit flight loads without failure for at least five minutes, and
- after 5 minutes and until the end of 15 minutes, the engine may be assumed to be shut down and the structure must be able to support the discrete source damage loads described in AC 25.571-1C.

8. FIRE ASSESSMENT OF ESSENTIAL FLIGHT CONTROLS. Essential flight controls that could be affected by a fire in the fire zone should be able to perform their intended function during any foreseeable fire in an adjacent fire zone.

a. Essential flight control structural components should be subjected to the effects of the prescribed fire test condition in the fire zone while assessing their capability to continue to perform their function. The assessment of mechanical components should include any tendency to warp, seize, jam or fail under anticipated control system loads with the prescribed fire test condition.

b. Essential hydraulic components including lines, actuators, seals and valves should be assessed to assure that the function they are intended to perform can still be accomplished under any foreseeable fire condition in the adjacent fire zone.

9. SHIELDING AND REDUNDANCY AND OTHER CONSIDERATIONS.

a. Shielding: Shielding may be provided to protect a component against the effects of fire. The adequacy of the shielding should be determined under paragraphs 7 and 8 with the defined fire conditions by assessing the results of applying the flame on the most critical location of the shielded component(s) with representative impingement.

b. Redundancy: All components and parts that could be affected by a fire in a fire zone should be fireproof or protected from the effects of fire. However, the fail-safe features of the design may be taken into account if it can be shown that no foreseeable fire condition could cause the loss of function of the alternate load paths or alternate control elements. The use of the standard AC20-135 flame has been found to be an acceptable representation of a foreseeable fire condition for assessment of redundancy. The effect of this flame impinging on a target loadpath should be assessed on the alternate loadpaths.

c. Aeroelastic stability: When, due to the effect of temperature, significant changes in stiffness and damping properties of parts occur, such as with elastomeric or non-fireproof materials, aeroelastic stability should be addressed accounting for those changes. The aeroelastic assessment should include flutter and whirlmodes and consider the most critical properties that could exist in a fire condition. It should be shown that the airplane is free from aeroelastic instability within the aeroelastic stability envelope of 25.629(b)(2).